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CONFERENCE ON ELEMENTARY BIOLOGICAL SYSTEMS AND ON BIOGENESIS* **/1

18448

Brief resumés of papers presented at a Colloquium on elementary biological systems and biogenesis at Paris in 1965 are given, including geological, physical, chemical, and philosophical aspects of the origin of life. Some papers attempt explanations of biogenesis based on metaphysical theories and speculative application of Darwin's postulates. The problems of extraterrestrial life based on meteorite studies, evolution of terrestrial atmospheric composition, electronic factors in biochemical evolution, ultrastructure of chloroplasts and mitochondria, geological factors in biogenesis, deterministic views on cosmology, etc. are covered. Author

Facsimile of Circular Letter to Participants

My Dear Colleague:

I would like to draw your attention to the fact that the participants in the Conference on Elementary Biological Systems and Biogenesis are exactly one month removed from the scheduled session.

Since you have accepted to be an active contributor, I would like to ask you, in accordance with my circular letter of October 9, whether the title that you gave me at that time is firm and, if this is not the case, to give me the accurate title.

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* Paris November 23-25, 1965; Conference rooms of the C.N.R.S. (National Scientific Research Administration), 15 Quai Anatole France.

** Numbers in the margin indicate pagination in the original foreign text.

I would be obliged if you would send me a short resumé, of one or two pages, as I had asked.

It is also necessary to obtain your binding agreement on the minimum time required for your paper and to give me the exact format of the still and motion pictures you will show (in the latter case, also their duration).

Since very little time remains for reproducing all resumés, establishing a final program, printing the program and the invitations, etc. I would appreciate greatly if you could reply before November 1.

Thanking you in advance for your assistance in my organizatory efforts for full success of our meeting, I remain

Sincerely,

(Signed)

Pierre Gavaudan, Prof.

Poitiers October 22, 1965

Secretariat of the Conference: Biological Station of Beau-Site,
25 Faubourg St-Cyprien
Poitiers (Vienne)

COLLOQUIUM ON THE ELEMENTARY BIOLOGICAL SYSTEMS AND BIOGENESIS /2

Paris, November 23-25, 1965

HONORARY COMMITTEE

President: Jean Rostand of the French Academy.

Members: Jean Roche, Rector of the Institute of the Paris Academy; A.I.Oparin, Director of the Institute of Biochemistry of Moscow, Member of the Academy of Sciences USSR; Sydney W.Fox, Professor University of Miami, Florida; I.Prigogine, Professor Faculty of Sciences

of the Free University of Brussels; E.Faure-Fremiet, Professor Emeritus of the Institute of the College of France; J.Orcel, Professor of the Natural Museum of History of the Institute.

Up-to-date list of members presenting papers, attending in an observatory capacity, or participating in the discussions:

J.Amiel (Prof., Faculty of Sciences, Paris).

E.Aubel (Prof., Faculty of Sciences, Paris).

J.Barraud (Prof., Faculty of Sciences, Paris): General Principle of Structure and System, and its Extension to Biology.

J.Besson (Faculty of Sciences, Poitiers).

G.Biserte (Prof., Faculty of Medicine, Lille): Thermal Polycondensation of Amino Acids, according to the Sydney W.Fox Reaction Kinetics Technique.

R.Buvet (Prof., Faculty of Sciences, Paris): Theoretical and Experimental Data on the Reconstruction in Vitro of the Primitive Stages of Biogenesis.

E.Callot (Prof. of Agronomy, Annecy).

J.Carles (Research Director, CNRS, Toulouse): Instauration, Correlations, and Subordination of Biochemical Cycles as Primordial /3 Condition of Biogenesis.

P.Chouard (Prof., Faculty of Sciences, Paris).

M.Dode (Prof., Faculty of Sciences, Paris-Orsay).

J.E.Courtois (Prof., Faculty of Pharmacology, Paris).

Dietrich (Delegation of General Research Sciences, Paris).

H.Doffin (Poitiers): The Crystallographic Character of Living Organisms and Biogenesis.

M.Eden (Prof., Massachusetts Institute of Technology, Cambridge, USA): Some Logico-Mathematical Problems on Biogenesis (in Cooperation with M.P.Schutzenberger).

E.Faure-Fremiet (Professor Emeritus, Inst. of the College of France, Paris.

Sydney W.Fox (Prof., Institute of Molecular Evolution, University of Miami, Florida): Terrestrial Origins of Macromolecules and Cells.

V.Frolov (Honorary Research Member, CNRS, Paris).

R.Furon (Prof., Faculty of Sciences, Paris): Geology and Biogenesis.

P.G.Le Gallic (CNRS, Paris): Biological Evolution, its Laws, and its Expansion in Time.

P.Gavaudan (Prof., Faculty of Sciences, Poitiers): Problems of Actual Constitution of the Cell and Biogenesis.

G.Mangenot (Prof., Faculty of Sciences, Paris-Orsay).

M.Lefort (Prof., Faculty of Sciences, Paris-Orsay): Ultrastructural Data on the Origin and Significance of Chloroplasts and Mitochondria in Cellular Organites, having Genetic Continuity.

F.Meyer (Prof., Faculty of Liberal Arts, Aix-en-Provence): Methodological and Ideological Aspects of the Problems of Biogenesis.

J.Monod (Prof., Faculty of Sciences, Paris).

P.Morand (Pharmacological Marine Ch., Toulon).

P.Nicolle (Institute Pasteur, Paris).

E.Kahane (Prof., Faculty of Sciences, Montpellier).

A.I.Oparin (Prof. and Director Institute of Biochemistry, Moscow, Academy of Sciences, USSR): Present Status of the Problem

of the Origin of Life and its Perspectives.

J.Orcel (Prof., Museum of Natural History, Paris, of the Institute): 4 Carbonaceous Meteorites.

H.Poussel (Prof., Faculty of Sciences, Poitiers).

A.I.Prigogine (Prof., Faculty of Sciences, Free University of Brussels): Evolutional Laws in Macroscopic Physics.

A.Pullman and B.Pullman (Profs., Faculty of Sciences, Paris).

J.Roche (Rector, of the Institute, Academy of Paris).

J.Rostand (French Academy).

J.Sadron (Prof., Museum of Natural History Paris, Director Center of Macromolecular Research of the CNRS, Strasbourg): Macromolecules, Stage of Molecular Evolution.

L.Salem (Research Member CNRS, Paris-Orsay).

M.P.Schutzenberger (Prof., Faculty of Sciences, Paris): Paper in collaboration with M.Eden; see above.

J.A.Thomas (Prof., Faculty of Sciences, Paris).

B.Thiriet (General delegation to the Scientific Research; Paris).

All members of the Conference are invited to check and complete this list, so as to establish the final program.

Poitiers, October 9, 1965 (Signed)

Pierre Gavaudan

Address all replies to the Secretariat of the Conference: Prof. P.Gavaudan, Biological Station of Beau-Site, 12 rue de la Jambe à l'Ane, Poitiers (Vienne).

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COLLOQUIUM ON ELEMENTARY BIOLOGICAL SYSTEMS AND BIOGENESIS /5

PROGRAM

TUESDAY, NOVEMBER 23

MORNING

9:30 - Opening Remarks by J.Rostand, President of the Honorary Committee.

10:00 - P.Gavaudan, Moderator: Homage to some Pioneers in Biogenesis.

10:10 - A.I.Oparin: Present Status of the Problem of the Origin of Life and its Perspectives.

10:55 - Discussion.

11:05 - A.Pullman: Electronic Factors in Biochemical Evolution.

11:35 - Discussion.

11:45 - J.Guastalla and M.Dupeyrat: Contribution to the Study of Electroadsorption.

12:05 - Discussion.

AFTERNOON /6

14:30 - J.Duchesne: The Problem of Meteorites and Life.

15:00 - J.Orcel: Carbonaceous Meteorites and their Possible Contribution to Proof of the Existence of Organized Extraterrestrial Life.

15:30 - General Discussion on Meteorites.

16:00 - R.Furon: Geology and Biogenesis.

16:20 - Discussion.

16:30 - P.Gavaudan and H.Poussel: Remarks on Some Biological Problems Posed by Evolution of the Terrestrial Atmospheric Composition.

17:00 - Discussion.

17:10 - Discussion on Subjects Selected in Advance by the Discussants.

18:30 - Social Hour.

WEDNESDAY, NOVEMBER 24 /7

MORNING

9:30 - Sydney W.Fox: Terrestrial Origin of Macromolecules and Cells.

10:15 - Discussion.

10:25 - G.Biserte: Thermal Polycondensation of Amino Acids, according to the Sydney W.Fox Reaction Kinetics Technique.

10:50 - Discussion.

11:00 - With Mr. Sadron as Moderator, Discussion on the Subject: Macromolecules and Molecular Evolution.

AFTERNOON /8

14:30 - F.Meyer: Methodological and Ideological Aspects of the Problems of Biogenesis.

15:00 - Discussion.

15:10 - J.Carles: Instauration, Correlations, and Subordination of Biochemical Cycles, as Primordial Condition of Biogenesis.

15:30 - Discussion.

15:40 - C.A.Bogdanski: Biological Event according to the Concepts of Modern Physics.

16:00 - Discussion.

16:10 - E.Kahane: Epistemological Consequences of Work on Biogenesis.

16:30 - Discussion.

16:40 - G.P.Le Gallic: Evolution of the Species, its Laws, its Expansion in Time, and Quantum Biology.

17:15 - Discussion.

17:25 - J.L.Destouches: Quantum Physics as Possible Aid for Biologists.

17:50 - Discussion.

* * *

THURSDAY, NOVEMBER 25 /9

MORNING

9:30 - R.Buvet: Theoretical and Experimental Data on the Reconstruction in Vitro of the Primitive Stages of Biogenesis.

10:15 - Discussion.

10:25 - M.Lefort: Ultrastructural Data on the Origin of Differentiation of Chloroplasts and Mitochondria.

10:55 - Discussion.

11:05 - P.Gavaudan: Cytology and Problems of Biogenesis.

11:45 - Discussion.

AFTERNOON /10

14:30 - J.Barraud: General Principles of Structure and System in Biology.

15:15 - Discussion.

15:25 - I.Prigogine: Remarks on the Thermodynamics of Biological Phenomena.

16:05 - Discussion.

16:15 - J.Moreau: Philosophical View on the Sense of Biological Adaptation.

16:35 - Discussion.

16:45 - M.Eden and M.P.Schutzenberger: Some Thoughts on Mathematical Problems Raised by Biogenesis.

17:15 - Discussion.

17:30 - Discussion on Subjects Selected in Advance by the Discussants.

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Suggestions: 1) The members of the Conference, authors of papers as well as discussants, are requested to submit a brief resumé of their possible discussion to the Secretariat of the Conference*.

2) Persons desiring to suggest a subject matter and asking for the floor, during the scheduled discussions on Tuesday from 17:10 to 18:00, Wednesday from 11:00 to 12:00, and Thursday from 17:30 to 18:00 are asked to submit their names before the session, to the Secretariat*.

Participation in specific discussions can be announced from Monday, November 22 on, either at the Quai Anatole France or by telephoning to the General Chemistry Laboratory of the Physics and Chemistry School (Laboratory of Buvet, Jus. 22 37).

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* Local Secretariat of the Colloquium at the C.N.R.S.

FRIDAY, NOVEMBER 20 /11

MORNING

9:15 - 10:15 - Inspection of the equipment used by R.Buvet in his research on primitive syntheses in vitro (General Chemistry Laboratory of the Polytechnic Institute of Physics and Chemistry of the City of Paris, 10 rue Vauquelin).

10:30 - Inspection of the collection of meteorites of the Mineralogy Exhibit of the Museum of Natural History, under the direction of Prof. Orcel, member of the Academy of Sciences (meeting at the Mineralogy Laboratory, 1 rue de Buffon, Paris, 5e).

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CONFERENCE ON ELEMENTARY BIOLOGICAL SYSTEMS AND BIOGENESIS /12

PARIS, NOVEMBER 23-25, 1965

ABSTRACT OF THE PAPER BY P.GAVAUDAN AND H.POUSSEL

REMARKS ON SOME BIOLOGICAL PROBLEMS POSED BY EVOLUTION OF THE TERRESTRIAL ATMOSPHERIC COMPOSITION

Purpose of the work. The authors attempt to investigate several biological problems, raised by the rise in oxygen pressure in the earth's atmosphere. As complementary factors, some recent data from biology and, specifically, from cytophysiology as well as some scheduled experiments, in combination with data from vegetal paleontology, might make it possible to establish the chronology of the stages of oxygen enrichment of the atmosphere.

Principal problems covered. Within the frame of available data, taking

also the opinions by Urey, Calvin, Berkner, and Marshall and other authors into consideration, various suggestions are made on the possible oxidative role played at the origin of life by the low oxygen pressures due to the photodissociation of water. Certain facts and various considerations, specifically the antiquity of Cyanophyceae (Cloud) seem to indicate that the chronology of the increase in partial oxygen pressure, as had been suggested by various authors, might have been too short and that it would also be necessary to take the ecological role of the oxygenated local environment into consideration. The origin of the first oxygen-accumulating porphyrinic pigments or aerobic oxidizing agents, the development of higher and lower plants, the establishment of the most advanced type of photosynthesis, the development of corresponding pigments in an anoxic environment, all pose quite delicate problems.

It is well possible that the concept of anaerobic phase would need some relaxation in strictness.

The authors mentioned their own work on the effects, at the cytological /13 scale, exerted by anoxia on the endoplasmic reticulum of higher plants and, along general lines, suggest an experimental approach to some of the mentioned problems.

Specifically, a study on the kinetics of increase in oxygen pressure over the course of ancient epochs seems justifiable from the viewpoint of experiments made on the constitution of oxygenated atmospheres from various primitive plants (resumption and elaboration, in a quantitative sense, of the classical experiments by P.Becquerel).

Prof. P.Gavaudan and Prof. H.Poussel: Faculty of Sciences, Poitiers, Biological Station of Beau-Site, 25, Faubourg St.-Cyprien, Poitiers

* *
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ABSTRACT OF THE PAPER BY SYDNEY W.FOX /14

TERRESTRIAL ORIGIN OF MACROMOLECULES AND CELLS

Experiments simulating cases of spontaneous geothermal generation predominantly yielded amino acids found in proteins. Under suitable conditions, all proteic amino acids are simultaneously condensed by heat into polymers which possess many of the properties of proteins. These properties include the following: definite proportion of each amino acid, limited heterogeneity, mean molecular weight of several thousands, digestibility by proteolytic enzymes, nutritive quality, and catalytic activity. Another property is the tendency to constitute structural units which have certain attributes of "biocells". This process, together with other phenomena, forms a conceptual continuum.

In agreement with known data, the sequence of the processes, proceeding by chain reaction from the primordial gases up to protocells, passing over the amino acids and primitive proteins, must have taken place in the various regions of primitive earth.

The historical development of the fundamental concepts is briefly reviewed, starting from the first discoveries by Pasteur.

TABLE 1 /15

PROPERTIES OF MICROPARTICLES SPONTANEOUSLY ORGANIZED FROM POLY-α-AMINO ACIDS

Property	Bibliography
Stability (at rest, centrifuging, cut)	8, 9
Microscopic dimension	2, 8, 9
Variability of form: spherules, shoots, filaments	16
Uniformity of dimension	9

Prevalent number	15
Stainability	14
Possibility of producing gram-positive or gram-negative particles	14
Solubility in dilute bases parallel to those of the bacteria	14
Reduction in hypertonic solution	9
Increase in hypotonic solution	9
Simulation of cell division	16
Possibility of electron micrography	4
Presence of a boundary layer	4
Selection of the boundary layer	16
Bilamellar character of the boundary layer	4
Lytic activity of ATP by suitable inclusion of Zn	3
Structural associations (analogous to algae)	15

TABLE 2 /16

PROPERTIES OF THERMAL POLY-α-AMINO ACIDS, COMPARED TO PROPERTIES OF PROTEINS

Property	Bibliography
Limited heterogeneity	12
Qualitative composition	5, 6, 12, 20
Quantitative composition	6, 7, 17, 18, 20
Molecular weight margin	6, 10
Staining test	5, 6, 20
Solubility	5, 6, 20
Inclusion of non-amino acids	10
Optical activity	10, 23

Properties of solvation and salting-out	6, 10
Precipitability by protein reagents	6, 20
Hypochromicity	23
Infrared absorption maximum	6, 10
Recuperation of the amino acids by hydrolysis	12
Susceptibility to proteolytic enzymes	6, 19, 21
Catalytic activity	10, 13, 23
Inactivation by heating in aqueous solution	23
Sequential "non-aleatory" (nonuniform) distribution of the residues	1, 2, 11
Nutritive quality	6, 22
Morphogenetic power	2

Possibility of polymerization of mononucleotides of polyphosphates under conditions applicable to amino acids.

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Prof. Sidney W.Fox, Institute of Molecular Evolution,
University of Miami, 521 Anastasia, Coral Gables, Florida

ABSTRACT OF THE PAPER BY G.BISERTE /18

THERMAL CONDENSATION OF AMINO ACIDS ACCORDING TO THE S.W.FOX REACTION KINETICS TECHNIQUE

In our work, we have picked up the fundamental concepts of work done by Fox and Harada on the thermal polycondensation of amino acids, basically orienting our research toward a kinetic study of the reaction and structure of the compounds formed.

The structure of condensation products was studied in detail, specifically the condensation products of glycocoll, alanine, lysine, phenylalanine, and tyrosine. In each of these cases, the results pointed toward a polypeptidic structure, starting with pyroglutamic acid. The carboxyl group of pyroglutamic acid is involved in a peptidic bond with the α-amino group of another amino acid. The total series is composed of n units, with n being variable. In the condensation products of glycocoll, for example, it is easy to separate polypeptides of this type up to n = 7 (pyroglutamyl-glycocoll, pyroglutamyl-glycyl-glycocoll, etc.). However, other reactions involving the rupture of the pyroglutamic ring are possible.

A kinetic study of the polycondensation of glycocoll with pyroglutamic acid substantiates the hypothesis established as to the polycondensation process. The reaction is of the first order with respect to the glycocoll and of the second order with respect to the pyroglutamic acid. These results show the similarity of this reaction with the polycondensation reactions of diacids with diamines and diols. Thus, the pyroglutamic acid has a double role, namely, that of initiator by its own presence and that of catalyst by the presence of its carboxylic group.

The condensation products of aspartic acid are of a special type; in /19

fact, aspartic acid, which is readily condensed by itself, yields condensation products of a higher molecular weight whose structure is that of a polyimide which is readily hydrolyzed in an alkaline medium into polyaspartic acid.

Basic lysine is readily polymerized, yielding a polylysine of three-dimensional structure, with peptidic linkage involving the ε-amino group of lysine in predominance over the linkage involving the α-amino group. The basic ornithine and the basic α,δ-diaminobutyric acid cyclizise, on heating, into their lactam. These findings are in favor of a polycondensation mechanism of basic lysine, initiated at the expense of the lysine lactam.

G.Biserte, Prof. of Pathological Biochemistry at the Faculty of Medicine of Lille, Place de Verdun, Lille.

* *
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ABSTRACT OF THE PAPER BY A.I.OPARIN /20

PRESENT STATUS OF THE PROBLEM OF THE ORIGIN OF LIFE AND ITS PERSPECTIVES

The process of evolution of carbon compounds and complex multimolecular systems derived from these, are at the origin of the appearance of life on earth.

The study of the first two stages of this evolution is already quite advanced, in particular:

1) the appearance of hydrocarbons and their closest derivatives;
2) the transformation of these initial materials into more complex organic substances (formation of the "primitive bouillon").

At present, research should be centered on the subsequent and more complex

stage which immediately precedes the appearance of organisms.

Metabolism, oriented toward a definite goal which is the characteristic trait of life, can only have been produced by a perfectioning of the initial systems. This perfectioning must have been produced by a phenomenon similar to that of "natural selection".

It is quite improbable that this latter phenomenon could have been produced at the molecular level. However, the author attempts to prove, in model experiments performed in his laboratory, that such a "prebiological selection" could have taken place at the level of multimolecular systems, in interaction with /21 the environment, as is the case for open systems.

Prof. A.I.Oparin, Member of the Academy of Sciences USSR, Director of the Institute of Biochemistry Bach Leninsky, 33 Moscow B-71.

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ABSTRACT OF THE PAPER BY C.BOGDANSKI /22

THE BIOLOGICAL EVENT ACCORDING TO THE CONCEPTS OF MODERN PHYSICS

The most accurate possible definition of the nature of living beings seems the factor, indispensable to any scientific consideration, referring to biogenesis.

All purely descriptive and biochemical biological definitions, limited to chemism and metabolism of living organisms, are followed today by biophysical and biocybernetic definitions. These latter apparently define the subject more accurately, within the frame of more general laws.

According to the terminology of modern physics, which considers any event*

* For footnote see following page.

in a system of space-time coordinates, the living being is only a case of a specific event (namely, biotic). Its peculiarity consists in the adoption of a highly heterogeneous structure, condensed and organized to such a degree within a specific steric frame that it can be considered a temporally stable homeostat. However, as is generally known from the theory of information, a homeostat is capable, to a certain extent, of resisting an exodetermination and specifically any entropy effects, while still pursuing its own anti-entropy program: Such an organism is capable of autoregulation by self-piloting and, occasionally, even by autodetermination, as is specifically the case in man. This is the reason for the fact that life is frequently defined by the concept of freedom of motion, detectable even in plants in which matter is capable of systematic displacement against the direction of the gravity vector.

The theory of information uses the term of self-organization, which is obtained by an improgramation of matter by particular algorithms (for example, /23 contained in the genome); the formation of any structure, including the biostructure, obeys the law of autorganization, in combination with the formula of the Second Law of Thermodynamics, carrying a negative sign. Each biotic event thus is only an anti-entropy system or, expressed more accurately, a negaentropy system. Man is not only such a typical system but, in addition, is capable of exteriorizing his anti-entropy power. Death signifies the loss of this capability.

The information theory also encompasses quite general laws which are obeyed by the phenomena of regeneration, auto-reproduction, hereditary transmission of "programation algorithms"; in addition, this theory investigates the mechanism

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* In view of the fact that matter, in some manner, is only a condensation of energy, the term "event" has been substituted, in modern physics terminology, for the term " ....."(word missing in original, Translator).

of formation of any anomaly of this transmission which, for example, shows in the phenomenon of aging and of mutation. This latter represents a classical example of the application of the cybernetic veto law, which is established with the intervention of a factor able to produce the new level of homeostasis. Homeostasis is based on the existence of feedbacks (negative feedback).

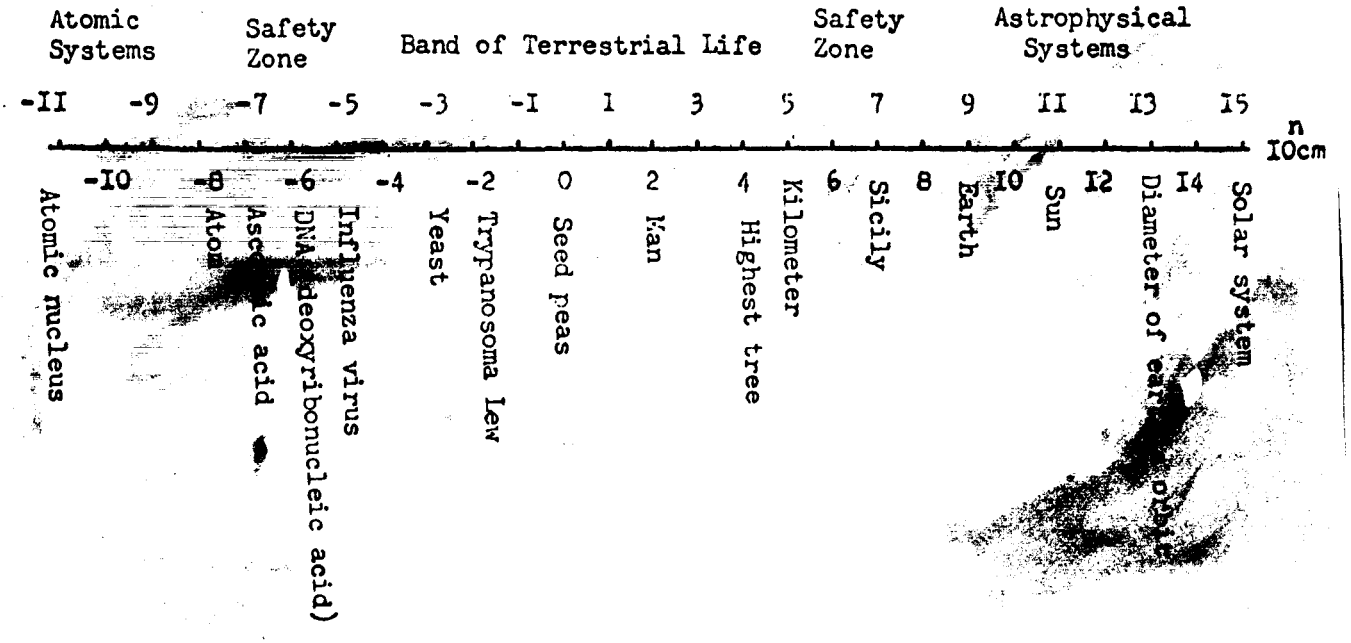
With respect to homeostats, it should be mentioned that nature knows not only the self-organization of biohomeostats but also of other homeostats. Among these abiotic homeostats, let us mention the case of the astroplanetary system and that of the atom. In the first case, the feedback which ensures the temporary existence of the system is based on an equilibrated feedback between the force of attraction of the planets by their star, which prevents them from leaving the system, and the centrifugal force produced by the revolution about the star along an orbit which permits very little deviation. In the second case, a similar feedback exists, except that here the magnetic force linking the electrons must be substituted for the gravitational force. This difference is insignificant in terms of the Einstein unified field theory.

On the basis of these examples, it is easy to explain why neither the very large nor the very small homeostats have ever been able to become biotic events if the latter, in accordance with their definition, are to be differentiated by the condensation of their parts. This would mean the end of existence of an astroplanetary or an atomic system, and the freedom of motion. These two attributes of any living being are incompatible with the fact of an obligatory circular motion of isolated parts of the system, with restricted freedom of motion.

All living beings on earth may be classified within the frame of intervals (C.G.S. system), in accordance with: dimensions from 10^{-5} to 10^{4} cm, mass from /25 10^{-15} to 10^{9} gm, duration of individual existence from 10^{3} to 10^{11} sec (exponents

rounded off to whole numbers). It is not surprising that the frame of their dimensions on our planet is distinctly separated by symmetric safety bands which, on the one end are represented by the atomic dimensions and, on the other end, by the dimensions of a celestial body. The biotic events thus are located at the center of a zone in which the circular motion is not indispensable for ensuring stability of the homeostatic system. In addition, the morphological diversity as well as the anatomic and physiological difference in the principal systematic groups can be represented by the parameter of dimension which refers to the index of the surface-to-mass ratio.

AMPLITUDE OF TOTAL-DIMENSION LEVELS OF PHYSICAL EVENTS IN WHICH THE ROTARY MOTION IS NOT INDISPENSABLE FOR EXISTENCE /24



Thus, the biotic events, being located in the privileged zone of the dimension levels, were able to form in a restricted spatial frame; in turn, this condensation was able to reflect on the building dynamics which, stage by stage,

has led to a heterogeneous complexification of matter, ensuring the existence of various functional currents. The biotic events have attained the phenomena of cerebralization and hominization, while the other models of the homeostatic systems were unable to reach such high evolutional levels within the framework of cosmogenesis.

Prof. C.Bogdanski, Director of the Laboratory of Biophysical Vitaminology at Warsaw, Domaine Saint-Paul, Montfavet 84.

* * *

ABSTRACT OF THE PAPER BY J.DUCHESNE /26

THE PROBLEM OF METEORITES AND LIFE

Carbonaceous meteorites have returned to the center of interest during the past 15 years, specifically with respect to a possible isolation of organic substances and, in particular, substances that characterize terrestrial life. Because of the development of highly efficient modern techniques, it has become possible to isolate an entire series of molecules of a biological nature, such as amino acids, nucleic acid bases, etc. However, the problem of the abiotic or biotic origin of these molecular species remains highly controversial, since recent experiments have shown that it is possible to synthetize them from simple molecules such as methane, ammonia, water, which are representatives of primitive atmospheres.

So as to offer a contribution to the solution of the difficulties raised by this dilemma, we used - for the first time - the method of paramagnetic electronic resonance in my laboratory; we were able to detect resonance lines in several carbonaceous meteorites such as the Cold Bokkeveld, Mighéi, Alais,

and Nogoya. The characteristics of the observed signals are comparable at all points to those discovered by us in lignites and also to those encountered in more developed coals, which are associated with free radicals which, in turn, are linked to carbonaceous structures present in this type of matter. This indicates that the organization of a part of the organic matter, present in the meteorites, must be similar to that characterizing terrestrial coal.

This permits the conclusion that this recent research has largely confirmed older concepts according to which a biogenic activity must have developed on celestial bodies from which the meteorites originate. /27

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ABSTRACT OF THE PAPER BY F.MEYER /28

METHODOLOGICAL AND IDEOLOGICAL ASPECTS OF THE PROBLEMS OF BIOGENESIS

1. Poor Logical Consistency of the Problem of Defining Living Matter

"Life" is only an abstract entity which would have preceded and sustained the progressive concrete succession of organized systems. This is the succession that, as the characteristic successive properties of the systems appear, elaborates and enriches its own concept. Going back in time, the systems become more and more pauperized without, however, anyone being able to define clearly a minimum concept to be used as an ultimate reference. At the other extreme, a rational interrogation on the origin of life obviously involves

human reasoning, as the most developed product of the effective history of life. This human mind is "defined" then (and only then) as an evolution one of whose characteristic properties is that of the capacity of self-retrospection and possibly of autodetermination. This constitutes its maximum concept which also does not constitute a logical reference in itself.

2. Ambiguity of the Principle of "Actual Causes"

1) Historical significance of this principle (Lyell, Darwin).

2) Discussion: The synthetic theory of evolution insists on the fact that the mechanisms involved in the evolution are themselves in evolution. The principle of "actual" causes must thus coexist with an inverse principle of "actualization of causes", which is a complementary principle that dialectizes the problematics. The types of intelligibility and of determinism are themselves still in evolutional progression.

3) Application to the prebiotic states and to elementary biological systems.

3. Conceptual Weight of the Selection Principle in Biogenesis /29

1) According to the synthetic theory, the evolution of the mechanisms of selection proceeds from a crude dichotomy (elimination - survival) to increasingly more subtile types of competition. Projecting backward toward the less developed systems, competitive selection is progressively obliterated and is replaced by an elementary alternative between what is intrinsically viable and what is not.

2) At the limit (elementary systems), survival and elimination are less a function of a competitive interference between the systems than of intrinsic conditions of possibility.

3) In this case, the prebiotic systems presumably are first justifiable by an epigenetic pre-competitive determinism (physico-chemical), a linear determinism which progressively is replaced by an "interdeterminism" by competition, which is the only one present in the advanced stages of evolution.

4. The Probabilistic Argument

1) Any evaluation of probability is relative at a certain initial state of conditions (or knowledge). To calculate an "a priori improbability" is an illegitimate step ("metaphysics" in the pejorative sense), from which only paralogisms can be drawn (Lecompte du Nouy).

2) Conversely, it is not unusual that, if the initial conditions of a system or of a situation are given, the subsequent behavior of the system appears as highly probable and even as necessary. However, in this case the problematics is not extended to the probability of existence of the initial conditions, which represents still another source of paralogisms. As a consequence, there is neither probability open to infinity nor arbitrarily limited probability.

3) Application to the classical confusion of the terms "theology" and "teleology".

5. Problematics of Biogenesis

1) Probability of appearance of certain complex systems.

2) Probability of the functional status of stationary self-maintained systems: internal and external conditions. An open system may have a stationary behavior, but under what conditions? What is the probability of existence of such conditions?

3) Problem of filiation of the systems: probability of spontaneous evolu-

tion of stationary systems toward states of lesser entropy ("probability of /30
increase in improbability"). Conditions? Probability of existence of these conditions?

6. Conclusions

The problem of filiation of structures, as the general problem of any genetic science (J.Plaget). Stability of stages and succession of stages.

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ABSTRACT OF THE PAPER BY J.CARLES /31

INSTAURATION, CORRELATIONS, AND SUBORDINATION OF BIOCHEMICAL CYCLES, AS PRIMORDIAL CONDITION OF BIOGENESIS

The hydrocarbons encountered in some meteorites probably represent the primordial matter of life and of biochemistry, which latter at most is a chemistry of carbon and phosphoric acid.

The living organism realizes a less stable and much more complex homeostasis than the atoms or the planetary systems; in addition, this homeostasis is not based on physical laws but on chemical laws which, because of the fact that these cause changes from one type of energy to another, involve the expenditure of energy.

The biochemical cycles convert energy but do not produce energy and, for making a complete cycle, require as much energy as they furnish or even slightly more. These cycles so to say mint the energy that they receive at the beginning and render it utilizable for the living organism.

A cycle can be established by a highly accurate specialization of reactions and by their linkage which presupposes a certain three-dimensional structure.

The citric cycle (di- and tricarboxylic acids, tetra- and hexacarbonic acids) no doubt has been preceded by the succinic cycle (mono- and dicarboxylic acids, di- and tetracarbonic acids) as is suggested by the portion they have in common, namely, the series of dicarboxylic acids. These two cycles no doubt have formed in a reducing environment.

Just as is the case for the degradation paths of glucose, these cycles are common to all living matter and require enzymes whose proteic molecule, for forming and reproducing, requires an accurate functioning of the genetic code and of the RNA messenger.

However, the institution of cycles, even with participation of the re- /32
production of proteic molecules, is not characteristic of life since all this can be realized by detailed programing; much more decisive is the coordination and subordination of the cycles, which permits the appearance of the first outlines of "conscience" and renders possible the first reactions of the instinct of preservation.

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ABSTRACT OF THE PAPER BY J.MOREAU /33

PHILOSOPHICAL VIEW ON THE SENSE OF BIOLOGICAL ADAPTATION

Subject to be elaborated: "The basic property of life no doubt is that of having been created itself, encompassing simultaneously all teleological and

regulatory aspects of its own phenomenology, with the appearance of this pseudo-force, this entirely contingent appearance of the law which is known to us as natural selection" (A.I.Oparin, translation and commentary by P.Gavaudan).

The underlined portion of the above statement agrees with the leitmotiv by Paul Wintrebert who, under the inspiration by Lamarck, considers adaptation the essential basis of the evolutional system.

A brief discussion of this system is given, from the strictly deterministic viewpoint. The so-called "teleological aspects" can be created simultaneously only if they meet the requirements of differential reconduction which characterizes any deterministic process. This teleological topic will be discussed with respect to the finality.

Does adaptation itself imply finality? This must be answered by yes or no, since such finality must be manifest everywhere or nowhere. We do not recognize any mitigated finalism, unless it would be subordinate to a prioritary determinism. However, if the irrational reveals itself at any point, its domain must necessarily be unlimited unless one could be shown, on an actual map, the boundaries of a "finalized" biology.

Adaptation exists at any instant of the phenomenon of life, in the state of fact as well as at the instant of substitution. However, the phenomenon continues, and the sense of the adaptation is the important point here. At the considered instant, adaptation is identified with the end: Finality of fact, as it is called by the teleologists. It is true that the "final" is encountered by us at each step, thus leading to the fallacy of using terminologies that give a static aspect to moving bodies.

In the eyes of the determinist, adaptation is a challenge of the living to the aggression by the environment. Always the same problem is involved: con-

comitance of the organ and of the function. Both are inseparable; in functioning, the organ wears out and, by this, orients itself in the sense of the function. An organ lives by functioning and dies as soon as it no longer functions; while it does live, it simultaneously transforms itself and adapts itself. Organ and function, alternately determining and determined, beget each other reciprocally.

The highly criticized aphorism by Geoffroy St.Hilaire, namely, that the function creates the organ, reduces to the statement that physiology determines morphology. Assuredly, the relation of equilibrium between organ and function excludes any finality, but man nevertheless opposes his teleologism to the /34 determinism of things.

Mutation: The evolutional variations of species can have resulted only from hereditary variations. "The only hereditary variations that are known to us in an absolutely certain manner are mutations" (J.Rostand).

Two types of mutations are differentiated: provoked mutations attributed to the genes and mutations of the protoplasm suffered by the gene that it had created. The new mutation becomes fully manifest only in the progeny. The chemical linkage of the mutations is basic for the continuity of life. This linkage, which can be compared to an equilibrium relation, involves a determinism which is effective on two scales, namely the ontogenetic and the phylogenetic scale. Chance, stipulated by Weismann and by numerous other geneticians, has no place in mutation which is defined once and for all. In addition, as stated by Paul Wintrebert, "the living organism, over the course of ages, cannot possibly have been the perpetual winner in a lottery of fortuitous mutations".

The living system, at any instant, is the winner because of a functional reaction and also because of an occasional, physiological regulation; finally,

for a new hereditary adaptation, the mechanism of adaptation is blueprinted on that of immunization.

As already stated by De Vries: "Just as physics and chemistry reduce to a study of molecules and atoms, the biological sciences must study these units so as to discover, in their combinations, the secret of the manifestations of the organized world". Both chromosomes and genes appear as the actual limits of structural representation of the living organism. Thus, it is the elementary unit, namely, the molecule, which is the seat of the intimate mechanism of life. There, the crucial phenomenon is spawned which confronts or - so to say - places in symbiosis, the organ and the function. At this scale, both form a single block by interpenetrating. At this scale, both internal and external medium are intermediate. To what does functioning actually and finally reduce? To the supply of external energy to the system.

From all this it follows that adaptation is a microbiological process, no matter what Albert Vandel thinks about it who states arbitrarily: "Adaptation is a teleological manifestation or it is nothing at all". We believe rather that adaptation proceeds in the immediate. Assuming that adaptation is the actual image of a deterministic process, such a system would be significative of an order of nature which does not aim toward a definite goal but reaches its goal by the epigenetic development of the living organism. Thus, any thought of teleology is excluded from this process, similar to the chart of a recording barometer.

Natural selection: This has no final goal and proceeds by elimination of unfit or unadapted organisms, i.e., by a purely statistical method. As soon as the selection assumes a positive value, it becomes synonymous with adaptation. This leads automatically and gradually to the conclusion that adaptation is a

generalized modification. It is not only the organ itself that becomes adapted; the defense system spreads over the entire organism, and the term "adaptation" presupposes a hodgepodge of internal and external influences, where mutation occupies a preferred seat.

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ABSTRACT OF THE PAPER BY R.FURON /35

GEOLOGY AND BIOGENESIS

The true problems of biogenesis can only be studied and solved by biologists.

Geology intervenes only by its historical study of the evolution of life on the surface of the globe, a globe that has been in existence for about 5 billion years.

Paleontologists are familiar with the evolution of living organisms during a period that extends from 600 million years to our day, a period which is frequently termed the "fossiliferous era". The antecedent period, the Lipalian, is much less rich in documents: comprising Radiolaria, unicellular algae, Coelenterata, Spongia, inarticulate primitive Brachiopoda, and a type of Annelida. To this must be added a certain quantity of Stromatopora, which are only forms of calcareous deposits produced by unicellular algae and bacteria. This leads up to one billion years.

The other four billion years of life on earth are represented by metamorphic terrains in which any traces of fossils have generally been obliterated. However, some dolomitic lime deposits and schists did show some traces of life,

frequently discovered only by biochemical methods.

Between 1500 million and two billion years of age, the following can be cited: the microflora of the cherts of Gunflint (Ontario, Canada), the stromatolites of the Pharusian in the Sahara, the "foraminifers?" of Birrimien of the Ivory Coast, Corycium enigmaticum, an alga of the Precambrian of Finland, and the shungite of Carelia.

Before the two billion year limit, life was represented by the stromatolite limestones of Bulawayo (South Rhodesia), dated at 2 billion, 700 million /36 years. These formations are highly similar to those still forming in the littoral zone of the Bahama Islands, Florida, and Western Australia.

These are the most ancient signs of life discovered until now by geologists. Beyond this, the rocks are of the metamorphic type up to granitization and show no hope at all for the discovery of traces of life.

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ABSTRACT OF THE PAPER BY J.ORCEL /37

CARBONACEOUS METEORITES AND THEIR POSSIBLE CONTRIBUTION TO PROOF OF THE EXISTENCE OF ORGANIZED EXTRATERRESTRIAL LIFE

Carbonaceous meteorites, particularly those of the Orgueil fall (May 14, 1864) and of Cold Bokkeveld (South Africa, in 1838), still occupy space in scientific journals and newspapers, ever since a sensational news item was published in the Proceedings of the Academy of Sciences of New York by three biologists and organic chemists (in 1961), B.Nagy, M.G.Meinschein, and P.J.

Hennessy.

These authors, by modern methods, picked up the earlier work done by S. Cloez and Pisani (1864 - 1868) and the more recent work by G.Mueller (1953) and M.Calvin (1961), demonstrating the presence of hydrocarbons, organic products similar to humic acids, and heterocyclic aromatic compounds. However, they erroneously attributed a biogenic origin to these substances and advanced the hypothesis that carbonaceous meteorites prove the existence of life on other planets of the solar system.

Some time after this, the same authors announced that they had discovered, in the meteorites of Orgueil, Migueia, and Ivuna, oval microscopic inclusions which were luminescent in ultraviolet light.

These inclusions have a certain resemblance to spores of algae. They stain readily with reagents that are conventionally used for demonstrating biological compounds.

From this, the authors concluded that fossilized relics of "organized elements" were involved, i.e., microorganisms belonging to the meteorite itself.

This conclusion seems entirely premature since the morphological resemblance in itself is insufficient to give a conclusive proof. In addition, the extent /38 of the coloration was not fully explained in the case in question.

Conversely, other chemists and mineralogists such as G.Mueller, E.Anders and coworkers, with the same justification, assumed that most of these "organized elements" actually are inclusions of minerals or hydrocarbons of abiogenic origin. This raises the question whether "organized" inclusions of terrestrial origin might be present in these meteorites, produced by pollution of the meteorites in the soil into which they had buried themselves.

It seems that this latter assumption has been proved by various researchers.

With respect to the existence of free radicals, demonstrated recently by M.J.Duchesne by means of nuclear magnetic resonance techniques, there is no need to invoke vital processes for generating such radicals. High-energy radiations (cosmic or far-ultraviolet rays) are able to produce these radicals during the passage of meteorites in cosmic space.

Thus - at the present state of the art - it is only possible to state that the substances isolated by organic solvents are those presently believed able to prepare the medium, in which then the conditions for the appearance of organized life will be realized.

The paper gives a general view over all research done on such meteorites from various viewpoints, including mineralogical, chemical, and physical aspects, classifying them with the other stone meteorites, from the perspective of hypotheses on the genesis of planetary systems.

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ABSTRACT OF THE PAPER BY J.GUASTALLA, J.MICHEL, AND M.DUPEYRAT /39

CONTRIBUTION TO THE STUDY OF ELECTROADSORPTION

Speaking in a general manner, a body dispersed in two immiscible superposed solvents will be adsorbed at the interface, if it is surface-active. If the surface-active solute is ionizable (for example, a long-chain quaternary ammonia salt, dispersed in an aqueous solution and nitrobenzene), passing an electric current through the interface will, in certain cases, produce modifications of the surface tension of the adsorption layer. These modifications manifest them-

selves in relatively extensive variations in the interfacial tension. An experimental variant demonstrates in a spectacular fashion the conversion of electric energy into a considerable mechanical energy, due to an electroadsorption process.

This phenomenon exhibits some formal resemblance with the electrocapillary phenomena produced between an aqueous solution and a molten metal. However, it is of importance to note that the constituents of the systems in which electroadsorption can be produced, do not differ basically from the constituents of biological systems and that the conversion of electric energy into mechanical energy takes place here by processes in which only ions participate.

Still another interesting feature of electroadsorption is the fact that it constitutes an example of structural modification of an interface under the effect of a stress.

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ABSTRACT OF THE PAPER BY B.PULLMAN /40

ELECTRONIC FACTORS IN BIOCHEMICAL EVOLUTION

A large number of molecules, playing a dynamic and essential role in the structure and functioning of living matter (purines, pyrimidines, porphyrins, pteridines, flavins, quinones, polyenes, polyphosphates, almost all of the coenzymes, etc.), are the conjugated heterocyclic systems rich in π-electrons and easy to dislocate. It is probable that at least some of these substances were associated with vital phenomena since the epoch at which life was born in its

primitive forms.

The use of conjugated molecules might have had several substantial advantages for the processes of biochemical evolution, whose exploitation might have facilitated or accelerated the development of life. These advantages primarily include the following:

1) Thermodynamic stabilization, always linked to the presence of conjugate π-electrons and manifesting itself by the appearance of a known increment in stabilization, known as dislocation energy or resonance. Its value may be quite high in the above-mentioned molecules; for example, it is of the order of 30 - 40 kcal/mole in pyrimidines, 50 - 80 kcal/mole in purines, and as high as 150 - 200 kcal/mole in porphyrins. Such a stabilization is of considerable advantage in natural selection. It might well be responsible for the multiplicity of functions occasionally linked to one and the same fundamental molecular skeleton (for example, that of porphyrin).

2) Radio- and photoresistance, accompanying thermodynamic stabilization (probably because of the production of excited states or of relatively stable radicals) and possibly even associated with a protective effect toward nonconjugated systems that are associated with the conjugated systems. Although /41 the various types of radiation are considered, with justification, as agents of probable synthesis of primitive biomolecules, it should be recalled that radiation also has a destructive effect on existing molecules. This is responsible for the large rise in resistance produced in this domain by electron shift.

3) Functional advantages, consisting in the fact that the reactions taking place on conjugated substrates may be connected with relatively extensive variations in free energy (hydrolysis of phosphates "rich in energy") or with relatively weak activation energies and reactive transition states (coenzymes).

The entity of these advantages, obtained from an electron shift, is intimately connected with the utilization by living matter, aside from carbon and hydrogen, of heteroatoms susceptible of participating in this shift in several of their valence states.

Let us add to this:

1) The above-mentioned factors frequently are emphasized in macromolecules.
2) These factors are encountered also in the structural characteristics of certain molecules assumed to have played an important role as essential intermediaries in the primitive syntheses that led to the biomolecules (for example, the dimer of HCN).
3) The role of the electron factors is not limited to the biochemical evolution but is detectable also in the biological evolution. For example, its probable role in the phenomena of mutation is clearly defined.

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ABSTRACT OF THE PAPER BY J.BARRAUD /42

GENERAL PRINCIPLES OF STRUCTURE AND SYSTEM IN BIOLOGY

The living being has been compared to a flame, to a crystal, and so on; just as well, in view of its cyclic activities, it could be compared to a pendulum.

To the flame there corresponds the thermodynamics of irreversible processes

in open systems (Onsager, Prigogine, Wiame, Bertalanffy, and others); to the crystal, molecular biology corresponds; to the pendulum, i.e., to cyclic processes in expansion, in a stable regime, and in a more or less damped regime, there correspond certain aspects of a general theory of systems, formulated by Bertalanffy but still to be developed.

The present paper has a more modest goal, namely, to define an abstract and general system notation (abstract, because of being general) which might serve as basis for a description of molecular and energetic phenomena in living beings.

In accordance with E.Schrödinger, we assume that the living being - comparable in this respect to a macromolecule - bypasses to a large degree the second law of thermodynamics and that, at the limit, a "model" can be substituted for this living being, which completely escapes this law. As is the case in a clock (considered in this sense as an organized system rather than an assembly of material elements), the living being (in biological equilibrium and in its adult phase) may be considered, from the system viewpoint, being at absolute zero*. To this, it is then possible to apply the third law of thermodynamics or Nernst's theorem: Its entropy is and remains zero.

This starting point permits a separate consideration of the material structure of the system, the exchange of matter and energy of which it is the origin, and its "logical" structure, for which we suggest a nonprobalistic definition since the probalistic aspect is linked exclusively to the "flow" of energy and matter that traverses this structure.

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* We did not retain another viewpoint of Schrödinger, namely, that the living being feeds itself in neguentropy (negative entropy), whose significance is not general but is nevertheless valid in some cases: "indispensable" amino acids, vitamins, etc.

This leads to opposing the notion of "information" involved in the bio- /43
logical processes (probalistic definition) by that of "operation" (deterministic definition).

In accordance with what is known on most biochemical mechanisms, this leads to the belief that the elementary biological systems function by stages or by "discrete" operations which are somehow quantified, without attempting to give this term the strict sense that it has in quantum mechanics.

In the case of an elementary system, we can establish that

$$I = \frac{u_0 q_0}{kT} \cdot O_p$$

where I is the quantity of information, in "thermodynamic" units, and O_p is the "quantity of operation", which is dimensionless; u_0 and q_0 are elementary "discrete" values of the variables of potential and position, serving to describe the phenomenon; k is the Boltzmann constant.

It is possible to set $w_0 = u_0 q_0$, which represents the elementary information energy for the system under consideration.

The factor O_p is completely determined by the logical structure of the system.

The factor $\frac{u_0 q_0}{kT}$ is linked to the probalistic aspect of the material process of which it is the seat.

The results can be extended to complex systems, by assuming that these are compounds of n elementary systems between which k linkages exist. In this case, one can represent the system by a single point in space having a configuration at (3n - k) dimensions and apply to it Hamilton's principle of least action or, which comes to the same, the Lagrange equations (linear system)*.

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* For footnote see following page.

On these bases, we can define a structural function which - at least theoretically - permits calculating the "operation quantity" O_p, involved in a determined process.

Taking the experimental conditions into consideration and referring the operation quantity to unit time, the operative power of the system can be defined (i.e., the number of elementary operations executed by the system in unit time).

This latter was determined for the case of active permeability of the /44 cellular membrane. From this, the "information output" per second and per mm^2 of membrane can be derived. The results were the same as those obtained by Branson, who developed his calculation by applying the principles of thermodynamics of irreversible processes to intracellular and extracellular compartments between which the membrane operates, whereas we attribute to the latter a logical structure.

It might well be that a determination of the logical structure of a living system must facilitate a determination of its material structure by experimental methods, just as the knowledge of the geometric properties of abstract triangles facilitates an experimental study of material objects with triangular faces.

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* It can be demonstrated that, finally, the general equation of oscillating systems will be obtained. Starting from this formalization and applying the Laplace transformation, A.Ducrocq was able to show that a study of linear systems can be approached as a general theory of impedance, a theory that can be extended also to nonlinear systems.

ABSTRACT OF THE PAPER BY E.KAHANE /45

EPISTEMOLOGICAL CONSEQUENCES OF WORK ON BIOGENESIS

Ever since the time that the concept of evolution has triumphed over the fixistic and creational ideas, it has literally invaded all scientific and philosophical thinking. Thus, spiritualism has been looking for a terrain favorable to its concepts. Such a field apparently was found when it was assumed that the course of events cannot be interpreted by properties of matter exclusively. A choice must be made between the enormously diverse possibilities offered by these properties. The necessity of a choice has a demonstrative value for the existence of this choice, with its corollary of metaphysical intervention, by assimilation with the old adage of proving the watchmaker by the existence of the watch.

This is one of the favorite refuges of modern spiritualism. Here, one encounters arguments based on such a highly improbable character of life that the latter could not possibly have appeared without favorable intervention. Other arguments are based on the number of amino acid chains obtained by calculation, which is so prodigious that a random appearance of proteins specifically able to fill a given function is quite unlikely. Still other arguments are based on the accumulation of chance mutations required for forming, in the "agglomerate of matter, some sort of arrangement in which they could persist" as stated by Diderot; such accumulations are so unconceivable that one has to come back to the idea of an orientation or of an orienting power. Finally, there are arguments based on the succession of changes that stake out the evolution by establishing an orthogenesis, whose obvious finality cannot possibly be the result of pure chance.

The experiments by Miller and his successors, which prove the first stage

preceding the biogenesis as conceived by Oparine, refute the above hypotheses with arguments whose significance seems primordial from the epistemological viewpoint.

By demonstrating the appearance of amino acids, puric and pyrimidic bases, and porphyrins under conditions at which one could just as well have expected the formation of any of the innumerous quaternary organic substances known or to be known, these experiments yield a much more accurate concept of necessity, as opposed to contingence. The compounds that form the substratum of life have not appeared by chance among all imaginable compounds but rather because of the fact that, in view of the suspected laws, their formation has been much more probable than that of most of the other compounds. /46

On this basis alone, it is already permissible to attempt a generalization: In virtue of natural laws, still to be defined, the condensation of simple molecules proceeds in the sense of these types of macromolecules that characterize living matter, the association of macromolecules obeys laws that lead them to coacervate systems within which organization finally develops, etc. The evolution of living species no more obeys pure chance than does a saline solution left to evaporate; thus, it becomes necessary to search for laws - and for principles forming the sources of such laws - on whose basis these specific adaptations are produced, with respect to which some authors objectively express the appearances in terms of orthogenesis while other authors, anthropomorphically, express them in terms of finality.

The discoveries, resulting from the modern concept of biogenesis, let us already guess at the path by which final victory of the scientific mind over the metaphysical mind will be ensured, which will be so significant that one hopes it to be peremptory. By giving an objective representation of the facts of

adaptation, of the appearances of finality, and of what is ambiguously called "the sense of evolution", this concept will finally place us on the path of an objective translation of the contemporary guiding principle of spiritualism, namely, the sense of life at the level of human psychism.

The fact that certain spiritualistic assertions make such a deep impression on the mind of many of our contemporaries no doubt is due to the feeling that they occasionally carry a reflection of objective reality. Unfortunately, these assertions distort reality by their aspirations and their metaphysical language. Nevertheless, a sane materialistic conception must not induce us to categorically deny this reflection of reality but rather to dissipate the fog surrounding it and to substitute for it an interpretation in conformity with scientific thinking.

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ABSTRACT OF THE PAPER BY J.L.DESTOUCHES /47

POSSIBLE ASSISTANCE BY QUANTUM PHYSICS TO BIOLOGISTS

1) It is generally known that the concept of wave mechanics has permitted a correct description of the structure of molecules and thus has explained a multitude of experimental data. This mechanics also has made it possible to classify cancerigenic agents and to explain the role of side chains in the long molecules in biochemistry.

2) One might ask whether theoretical physics offers further explanations. Obviously, the notion of "living" is beyond the language of the physicist, which

means that he cannot go far in meeting the biologist. However, insofar as the biologist expresses himself in terms of molecules, theoretical physics can offer some assistance.

It is a fact that any manifestation of life takes place in a fluid medium and that wave mechanics apparently offers an explanation for this fundamental role of fluids as well as for the remote influence of macromolecules throughout the fluid. Practical experiments will have to be made to determine whether these conclusions are valid. Some authors have made use of quantum theories for discussing the origin of life.

3) Bohr had attempted to describe the living organism by a certain "com- /48
plementariness". This can be further defined at present: One microphysical aspect of life can be described by quantum theory, while some other aspect can be described by cybernetics; these two aspects are each partial and complementary, meaning that one cannot contain the other. However, this does not mean that this yields a satisfactory description of manifestations of life; only the biologist will be able to develop adequate schematizations in this respect.

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ABSTRACT OF THE PAPER BY R.BUVET /49

THEORETICAL AND EXPERIMENTAL DATA ON THE RECONSTRUCTION IN VITRO OF THE PRIMITIVE STAGES OF BIOGENESIS

Most of the papers published recently with respect to the primitive conditions of formation of living beings have had the object of demonstrating, by practical experiment, that certain stages of chemical evolution whose interven-

tion has been evoked in this respect, can actually be reproduced in the laboratory. In addition to these papers, some theoretical reports discussed the character of thermodynamically open systems, which are possessed by all living systems.

This particular paper intends to demonstrate that a combination of these two aspects might yield a coherent overall view on the formation process of living systems, from a primitive medium in thermodynamic equilibrium.

The concepts adopted in developing this analysis are enumerated in the paper. Basically, they consist in a systematic consideration, relative to the principal cause of evolution, of the permanent influx of polychromatic solar energy to which the peripheral terrestrial medium is subjected, and include the statement that the general laws governing such an evolution are contained in the analysis of transformations of such open chemical and electrochemical systems.

In a first portion of the paper, this general principle is elaborated, by differentiating the following successive stages:

Chemical evolution: The start of this evolution takes place in a medium in equilibrium, analogous to the primitive atmosphere, and maintained by the supply of energy of any type but having a quantum level above 10 - 12 ev. Experimental results, concerning the treatment by electric discharge of reducing gaseous media at reduced pressure, are cited in this respect.

Macromolecular evolution: Data concerning the spectrophotometry of alkaline solutions of amino acids show that this phase of evolution may have taken place under the influence of luminous energy influx at wavelengths close to 2000 Å.

Electrochemical evolution: It is shown that, since the result of /50

anterior stages is the formation of coacervate phases, separated by aqueous solutions containing metastable chemical energy and relaxed after dissolution in the coacervate phase, such a situation, at the level of the coacervate globules, would create a system of transport processes that might lead to a structuration of these globules.

In a second portion of the paper, the status of theoretical analytical methods for such systems of nonisolated transformations is briefly reviewed, specifically with respect to the following points:

Origin of the basic postulates that can be used here, specifically in the case of chemical transformations.

General theorems of evolution that can be derived from this.

Application of these theorems to typical examples of evolution of nonisolated systems, which must necessarily be developed.

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ABSTRACT OF THE PAPER BY P.GAVAUDAN /51

CYTOLOGY AND PROBLEMS OF BIOGENESIS

Purpose of the Work

The purpose was to define the contribution of recent results of general cytology to the study of problems of biogenesis.

Main Topics Investigated

General cytology (vegetables, animals, Protistae up to bacteria and viruses) offers a multiplicity of known facts but also numerous puzzles in the domain of the microanatomic inventory as well as in that of the functional significance of

certain structures, their actual origin during the course of life, and of cellular differentiation.

Known facts and various problems are reviewed, specifically with respect to the basic constituents of the cell and its organites, cytoplasm and endoplasmic reticulum, plasts and mitochondria, Golgi's apparatus, centrosomes, and kinetosomes.

The notion of genetic continuity of the organites is studied, and a brief description of the basic data is given. The nuclear apparatus is disregarded, since its genetic continuity obviously is out of the question.

It could be hoped a priori that the mode of perpetuation and multiplication of organites, on the basis of ontogenic-phylogenic relations, might yield some information on the antecedent development of the totality of the cellular system. However, the situation is complicated because of the possibility of two different hypotheses:

1) It is not known whether the cell must be considered as an integrated whole whose contemporary most complex types represent a quasi- /52
atomic unit (in the etymological sense of the term), both on the phylogenetic and on the ontogenetic plane, built up during the development and largely by epigenesis.

2) It is also not known with certainty, although various reasons exist for suspecting it, whether - at least in part - the cell might not be the result of an association of elementary entities each of which originally had its own individuality.

Some authors such as Ehret assumed a strict epigenetism and believed that the structural complexity of the cell originated over a series of dichotomic differentiations, from a very small number of organites. The author of this

paper restricts himself to giving these two hypotheses, without deciding in favor of either.

It is also possible to assume a bastard solution, giving room to an epigenetic phylogeny by cellular differentiation induced by certain elements as well as to an associative phylogeny from subunits.

On the one hand, a categoric proof for the formation de novo of certain organites reduces to demonstrating, during their ontogenesis, the passage between molecular and organized matter.

On the other hand, the proof of a rigorous genetic continuity, for other organites, seems to suggest the possible significance of endosymbiosis.

Several reports indicated the extent to which the limit is difficult to define between an endosymbiotic parasite and an organite (Sonneborn).

Another important problem was mentioned by the author. Among the simplest unicellular contemporary living organisms there might well be some that give us a picture or at least an idea as to the most primitive forms of life as it existed long ago. In principle, the smallest objects could also be (conditionally) the simplest. Everyone will agree on the choice of bacteria to keep this role of living-unit models relatively primitive. Modern data on the structure of bacteria seem to indicate that these constitute so-called protocells. Despite the fact that they have a relatively well-defined and highly differentiated organization, bacteria certainly are quite low on the evolutional scale. The structures and functions of these organisms are only homologs of those of higher cells.

It could be tentatively assumed, in agreement with Oparin and Sidney Fox, that the so-called eobionites belonged to a class of prebiological objects, having dimensions of the type of the coacervate particles and the proteinoid

spherules.

Because of their dimensions which are much below those of the average /53 contemporary cell, bacteria seem to represent sizes exactly intermediate between the living world in the strictest sense of the term and the multimacromolecular prebiological world. In some cases, bacteria, which are already highly reduced cells, can be even reduced further in size until they almost come even with the plurimolecular world. This leads to the problem of the smallest living unit.

The critical sizes of cells are encountered in the so-called PPLO organisms and in viruses (for simplification, we will consider here only the bacteriophages). Organisms of the type of PPLO are particularly interesting because of their possibility of autonomic life and because of the relatively small number of macromolecules contained therein (only about 1000). In these miniaturized cells, life nevertheless is "in full swing" compared to the way of life of bacteriophages that are singular objects, some of which cannot be classified and cannot be defined other than by name. We should mention that some saprophytic PPLO are known to live in relatively ordinary media. This does not mean that the PPLO are to be considered as primordial organites; however, useful information can be obtained from their ultramicroscopic organization, at a scale of dimensions satisfying the notion of a minuscule primitive object, already alive*.

Bacteriophages naturally are obligate parasites, meaning that they have no proper metabolism in their mature or adult form, at which they represent only a sort of seed (a seed will sprout by itself only in a suitable medium: water and heat). In general, the basic attributes of a "real" life of the "cellular type"

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* The problems of minimal dimensions of the living object has been treated also by Staudinger and Schrödinger.

and "fully active" cannot be given to bacteriophages.

However, even if one does not wish to classify these phages among the original organisms that preceded the cells themselves, this does not exclude the mystery of their significance. In addition, it is reasonable to believe that bacteriophages, known since only 50 years, are just as ancient as bacteria, which are known to have existed for more than two billion years. This possible antiquity of bacteriophages raises problems as to their significance within the framework of primitive life. A phage is almost as complex as a cell;* it has /54 already more "astute" differentiations than microorganisms of the type of PPLO. There is no doubt that phages have known an anterior evolution, which might have been quite as complex as that of bacteria. It is now a question which of the two, phage or bacterium, have assisted at the birth of the other. Have they been born together, and how and why?

In the phage, we encounter an evocation of symbiotic properties which, in the prophage, involve those possibly present in certain cellular organites, in the assumed case of a well-balanced endosymbiosis.

Thus, the phages may well be the evidence of an almost vanished biological world; in any case, the problem of their origin cannot be solved at present.

The contribution of general cytology, taken in the broadest sense of the term, is only suggestive at present but is by no means zero. Such contribution, for the time being, is restricted to an acknowledgement of various new problems and to the opening of special research channels. Any basic progress in cytology will further contribute to the solution of problems in biogenesis; however, such a research program is of the long-term type.

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* Naturally, in the practical absence of enzymes; nevertheless, this involves a "protist" or "zoospore" structure because of the extraordinary differentiations detected under the electron microscope.

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ABSTRACT OF THE PAPER BY G.P.LE GALLIC /55

EVOLUTION OF THE SPECIES, ITS LAWS, ITS EXPANSION IN TIME, AND QUANTUM BIOLOGY

The study of nature and of the origin of living beings encounters not only the difficulties of other sciences that obscure the sense of truth but new difficulties, produced by the fact that psychism is intimately connected with vital manifestations.

Fortunately, various investigations are in existence in which the evidence is manifest, and these are the data that are retained by science.

Paleontology is based on comparative anatomy and on the study of fossils.

Comparative anatomy of living systems defines degrees of general organization along branchlines or subclasses and arranges these degrees by increasing values in two principal orders, namely, that of Protista - Coelenterata - Annelida - Arthropoda and that of Protista - Coelenterata - Bryozoa - Echinodermata - Chordata. Lessertiseur assumed that this second principal series comprised either six or seven or eight branchings.

Obviously, the study of fossils concerns the only well-known fossils which are all from the post-Silurian period. These primarily comprise fossils that permit following the expansion of vascular plants and the branching of the Chordata - Vertebrata. Consequently, fossils indicate the last branching of one of the two principal animal suites, defined by comparative anatomy, at the exclusion of the preceding.

Paleontology distinguishes the existence of phyla formed from chain-like stages at a maximum number of 8 and, exceptionally, of 9. Each stage of a given phylum is constituted by several parallel phyla of lesser importance. These phyla obey the four following laws:

1) Parallel evolution must be understood in a general manner, whether it is simultaneous or not.

2) The characteristics of the various stages of a given phylum have voluminosities that increase in time, as though they were values of an entity common to these stages: the generalized character of the phylum. Each voluminosity can be measured, and the measurement of the n^{th} stage is proportional to the n^{th} term of a Fibonacci sequence.

3) The intervals separating the appearances of the stages of one and the same phylum or of parallel phyla are equal and can be denoted by T. The value /56 of T of a given phylum is 1/8 of the value of T of the phylum next in importance.

4) The phyla develop simultaneously in accordance with several generalized characteristics. A law similar to that of quantic selection is observed, which manifests itself by allometries.

These laws, obeyed by post-Silurian fossils and by fossils contemporary to the expansion of the Chordata - Vertebrates, can be extrapolated to the less organized branchings whose comparative anatomy induces the existence at numbers of 6 or 7 or 8.

Since the branching of the Chordata - Vertebrata spreads its eight subclasses over 360 million years, the evolution of species can have started at the earliest about 2900 millions of years ago. Other indications permit the assumption that this extreme date is the true figure. Consequently, all the possible large living groups have already appeared. This conclusion results

from an extrapolation to all phyla of a value 8 of the maximum number of their stages. This extrapolation becomes necessary if the overall trend of the theory of François Meyer, based on the observed laws of known fossils, is to be used as basis. Apparently, fossil bacteria lead to the same conclusion.

This is the main reason for discussing the orthogenesis of bacteria in this connection.

The quantitative laws, observed on the phyla, define the parallel evolution and its compatibility with any theory of evolution of species imagined in accordance with the genetics of populations. This incompatibility is explained by the fact that the loci are dislocated on the nucleic acids and that the genes have only an approximate existence. Consequently, the path of a gene in the individuals of a long line is not definite, whereas genetics is an accurate science which assumes that the paths of mobile organisms are rigorous. The inapplicability of the genetic theories beyond a rather restricted domain does not mean that a science of the evolution of species is impossible. Such a science can be quantic, as is chemistry in general and chemistry of nucleic acids in particular.

In fact, the quantitative laws of paleontology are identical to the evolution of a quantified system with several quantum numbers, being luminescent, circularly dichroic, and autocatalytic whose evolution operator would be a real or imaginary inertia. Let us recall that autocatalysis is a common chemical phenomenon whose existence Einstein has demonstrated in the creation of photons within an assembly of molecules or of excited atoms. In addition, this autocatalysis of photons is presented as referring to the same wave. In fact, both laser and maser effects have proved that photons, autocatalyzed by a first photon, were in phase with the latter. Thus, the emitting atoms or molecules,

for the very short time of collective emission, cease being a true mixture and assume certain characteristics of a pure case.

It is certain that the laws of paleontology are those of the chemical evolution of nucleic acids. It is probable that some of these laws are those of the evolution of any giant molecule.

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ABSTRACT OF THE PAPER BY I.PRIGOGINE /57

REMARKS ON THE THERMODYNAMICS OF BIOLOGICAL PHENOMENA

The thermodynamics of irreversible phenomena is applied to a discussion of some general characteristics of biological phenomena. The two following problems are investigated:

a) enrichment of compounds in the stationary state, whose concentration is very low at thermodynamic equilibrium;

b) possibility of chemical reactions fluctuating in time.

The author also discusses the correlation between energy flux and organization, based on methods of the thermodynamics of irreversible phenomena.

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ABSTRACT OF THE PAPER BY M.LEFORT /58

ULTRASTRUCTURAL DATA ON THE ORIGIN AND DIFFERENTIATION OF CHLOROPLASTS AND MITOCHONDRIA

Modern investigations have confirmed the ancient idea of the independence of plasts and mitochondria.

However, to this definite genetic independence there corresponds - on the one hand - a convergence of structure at the macroscopic as well as at the molecular level and - on the other hand - a narrow parallelism of functions.

Since these two types of cellular organites have the role of supplying the necessary energy to the cell, one by photosynthetic means and the other by oxidative means, their activities seem closely interrelated.

Thus, in certain organisms such as in the genus Euglena, the absence of light and photosynthesis is compensated by a phenomenon in which the energy apparently is furnished exclusively by the other metabolic process, namely, that of oxidative phosphorylation.

With respect to the regression of chloroplasts, this means an extraordinary development of mitochondria.

The differentiation of these elements apparently depends on the nucleus and on an adaptive mechanism, sensitive to light in the case of plasts and to oxygen in the case of mitochondria, which permits the cell to maintain its energy level. The author specifically discusses the genesis of chloroplasts and the hypothesis of the endosymbiotic origin.

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ABSTRACT OF DISCUSSION BY M.EDEN AND M.P.SCHÜTZENBERGER /59

SOME THOUGHTS ON MATHEMATICAL PROBLEMS RAISED BY BIOGENESIS

The theory of information and the theories of auto-adaptive and automatic systems are frequently used in discussions on the origin of elementary biological processes. In so far as one speaks here of the same objects studied by mathematicians, it seems that some limits must be placed on the explicative possibilities of these notions. The same statements hold, in a more general sense, for other models of higher organization (perception or language), despite the efforts made to obtain technological applications from these theories.